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Clean Air Strategy for Alberta

Alberta
ENERGY

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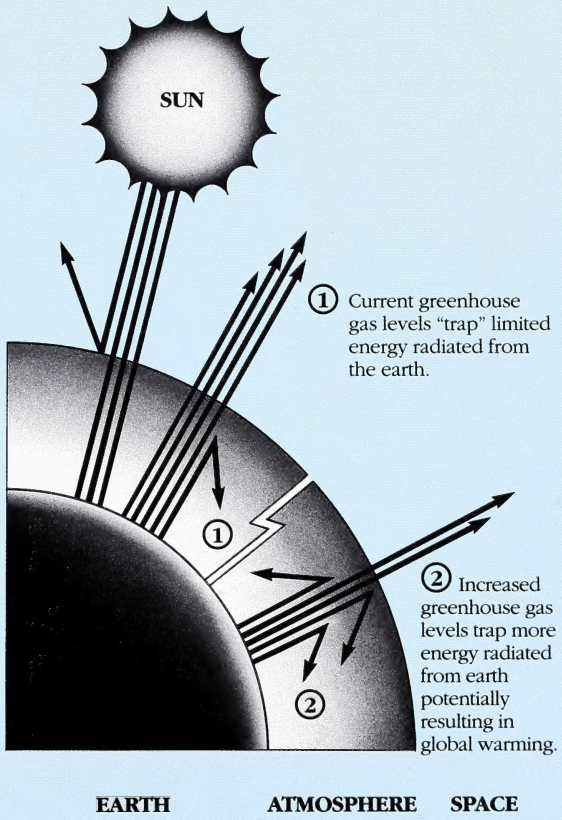
Clean Air Strategy for Alberta

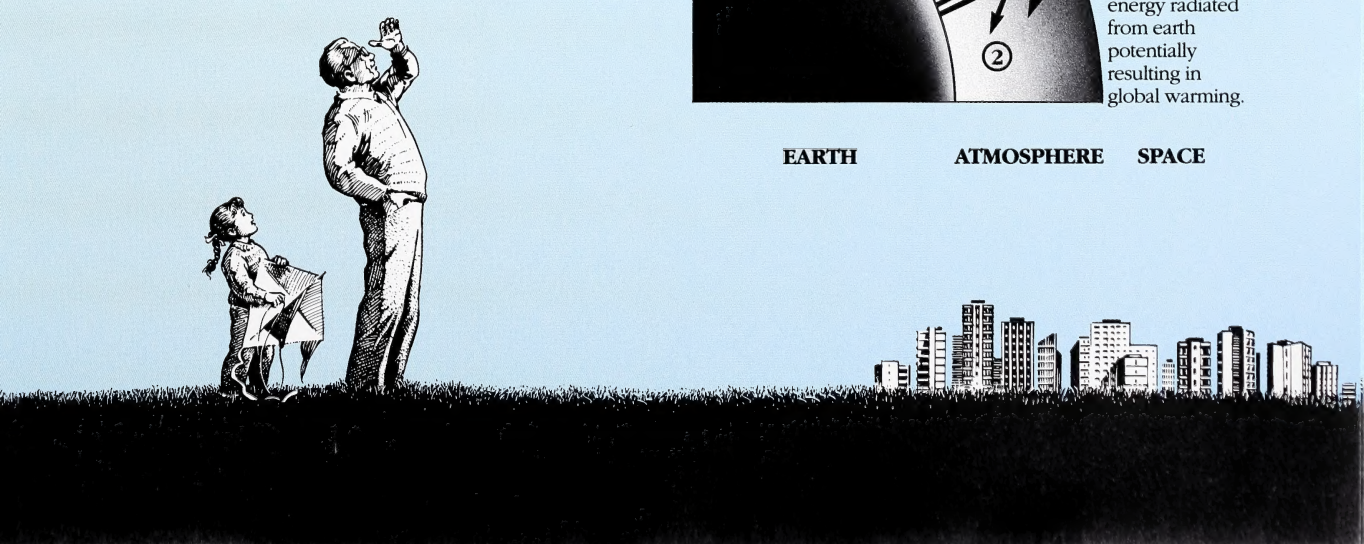
THE GREENHOUSE EFFECT

What is the Greenhouse Effect?

Life on earth is possible because the sun provides energy and warmth. The sun's rays pass through the atmosphere and are absorbed by the earth's surface, which heats up and radiates energy back into space. Some of the gases in the atmosphere capture and hold radiated energy, keeping the surface of the earth warm, much as the glass of a greenhouse keeps the plants inside warm. Without these greenhouse gases such as carbon dioxide (CO_2), all radiated heat would be lost into space and the surface of the earth would be cold and barren. This natural phenomenon acts like a blanket around the earth, is essential for life, and is often referred to as the greenhouse effect. Man-made emissions are leading to increased amounts of greenhouse gases in the atmosphere. The increases in greenhouse gases are trapping more of the energy radiated from earth and are likely to lead to global warming and weather extremes.

The possible impact of human activity on the greenhouse effect was first recognized in the early 1800s. By the turn of this century, calculations were being made relating increases in atmospheric carbon dioxide to temperature change. In the early 1900s it was estimated that doubling or tripling the amount of carbon dioxide in the atmosphere would lead to a temperature increase of up to nine degrees Celsius. Since then, carbon dioxide levels have increased by 26 per cent, and global temperatures have increased approximately 0.5 degrees Celsius.





Sources

Man-made greenhouse gases include those manufactured and those released due to processes controlled through human activity (eg. the burning of fossil fuels). Some greenhouse gases, such as chlorofluorocarbons (CFCs), are entirely man-made while for others, such as carbon dioxide, only a small percentage is man-made. While man-made greenhouse gases are a small percentage of the overall total, they are changing the balance. The most significant greenhouse gases are shown in the following table.

Greenhouse Gases and Their Contribution to Potential Global Warming

Greenhouse Gas	Current Greenhouse Gas Contribution	1750-1800 Levels in Atmosphere	1990 Levels in Atmosphere	Current Annual Growth Rate
Carbon Dioxide (CO_2)	49%	280	354	0.5 %
Methane (CH_4)	9%	0.79	1.72	0.9 %
Chlorofluorocarbons (CFCs)	20%	–	CFC11 280 CFC12 484	4.0 %
Nitrous Oxide (N_2O)	4%	288	310	0.25 %
Ground Level Ozone (O_3)	14%	38	52	1.0 %*
Other Gases	4%	–	–	–

Concentration Level Units: CO_2 & CH_4 - parts per million by volume
CFCs - parts per trillion by volume
N_2O & Ozone - parts per billion by volume

*northern hemisphere

Source: Environment Canada, 1990

Not all of these gases make an equal contribution to the greenhouse effect. For instance, one molecule of methane (CH_4) has 20 times the impact of a molecule of carbon dioxide; nitrous oxide (N_2O) 200 times; ground-level ozone 2,000 times; and a chlorofluorocarbon molecule has from 13,000 to 20,000 times the impact of a molecule of carbon dioxide.

Water vapour also is an important natural greenhouse gas. It is expected to increase in response to global warming.

Fossil fuels, such as oil, gas and coal, while important sources of energy and revenue worldwide, have been identified as major contributors of man-made greenhouse gases.

As an example, Canada contributes 480 million tonnes, or two per cent of the world's annual man-made carbon dioxide. Although this is a small portion of the larger global problem, Canada's per capita contribution is one of the highest, mainly due to our industrial base, our cold climate and our energy-intensive lifestyle. Due to its large fossil fuel industry, Alberta is the leading per capita producer of carbon dioxide in Canada, and second largest, in absolute volume, to Ontario.

The Effects

The volumes of man-made greenhouse gases are increasing and as a result are changing the balance of gases in the atmosphere. There is considerable debate among the world's scientists about the potential effects of this change in balance. Some scientists use complex computer models to simulate what might happen if, for instance, carbon dioxide concentrations in the atmosphere double (at the current rate of increase this could happen in 50 or 60 years).

There are major uncertainties about the effect – one way or the other – of cloud cover and the circulation of ocean water on global warming. While there is not agreement on the amount and location of climate change, it is estimated the average global surface temperature could increase one to five degrees Celsius, and that there could be substantial change in precipitation patterns.

It is believed northern latitudes (including Canada) would be affected more than equatorial regions; however, the effects of higher temperatures, accompanied by rising sea levels and changes in precipitation would be global. Food production could be affected by both coastal flooding and more frequent and severe droughts. Fresh water supplies, forests and land use could also be affected.

Weather could become more extreme. In low-lying coastal areas, rising sea levels caused by a combination of melting glaciers and polar ice and the expansion of the oceans as they warm, could require relocation of the population or major diking projects to prevent flooding.

An Alberta Research Council report released in November 1989 indicates temperature increases of about one degree Celsius in the 1980s compared to the average temperature of the previous 30 years. It predicts that if global atmospheric levels of carbon dioxide and other gases associated with the greenhouse effect continue to escalate at current rates, Alberta's climate may resemble Colorado's in 40 to 50 years. Higher temperatures and evaporation could harm drought-prone areas.

The Future

Despite the uncertainties and continued debate, there is general agreement that actions should be taken now to reduce man-made greenhouse emissions, particularly if reduction measures also have positive social and economic benefits, such as improved energy efficiency. Immediate action will not produce immediate results but will have beneficial long-term effects.

Further Information

Air quality issues – greenhouse gases, acid deposition (acid rain) and smog – cannot be addressed in isolation. Their complex inter-relationships make achieving the goal of clean air for the future a challenge for individuals, industry and governments alike. The Clean Air Strategy for Alberta is providing an opportunity for Albertans to participate in meeting that challenge.

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Glossary

Other information on greenhouse effect:

- *Climate Warming? Exploring the Answers.* Environment Council of Alberta. 1990.
- *Focus on Greenhouse Effect.*
- *The Changing Atmosphere Conference statement.* 1988.
- *Literature Review on the Greenhouse Effect and Global Warming.* Alberta Research Council et al. August 1990.

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ACID DEPOSITION (ACID RAIN)

What is Acid Deposition?

Acid deposition is a broader term than acid rain, but the two are often used interchangeably. Worldwide, the processing and burning of fossil fuels produce sulphur (S) and nitrogen oxides (NO_x). Most acid rain is caused by emissions of sulphur oxides (SO_x) and nitrogen oxides which in the atmosphere are converted chemically to sulphuric acid (H_2SO_4) and nitric acid (HNO_3), among other products. Diluted forms of these acids, and other substances, can fall to earth as rain, snow, sleet, hail, or fog. When it is not raining, the oxides interact directly with soil, vegetation and water in a variety of ways referred to as dry deposition.

Levels of acidity are shown on page two on the pH scale which provides everyday items as reference points.

The term acid rain refers to rainfall with a pH less than 5.6 which is the pH of distilled water containing atmospheric carbon dioxide. In Alberta the pH of rain averages about 5.5, but it has been recorded as low as 4.3 and as high as 8.2.

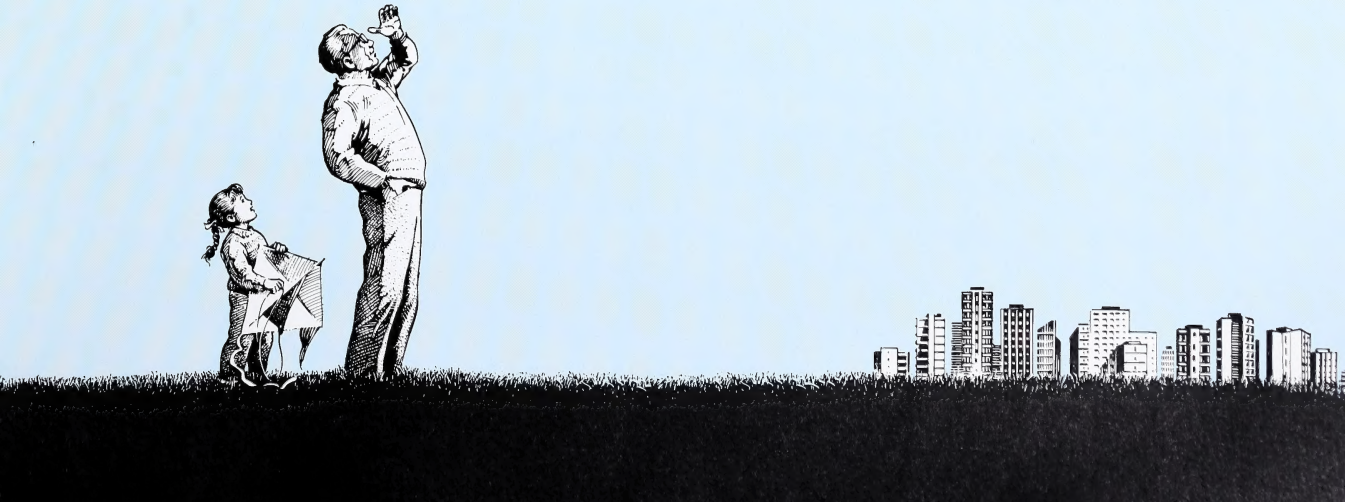
There are naturally occurring circumstances which can affect acid deposition. For example, in the prairies natural levels of airborne alkaline dust help to neutralize rainfall acidity and raise the pH. Much of Alberta is less susceptible to acid deposition damage than is Eastern Canada because of Alberta's generally alkaline soils and bedrock. However, some areas of the province such as the northeast and pockets elsewhere are highly sensitive.

The issue of acid deposition is not new. The term "acid rain" was coined by Robert Angus Smith in 1872 who referred to sooty skies over Manchester, England in his publication *Air and Rain: The Beginnings of Chemical Climatology*. In recent years, a great deal of attention has been given to acid deposition as many countries around the world reported lifeless lakes, damaged forests and property damage. A concern is that pollutants discharged in one country drift across borders to settle as acid deposition and affect the ecosystems in other countries. Eastern Canada, for example, has been affected by emissions from the North Eastern United States.

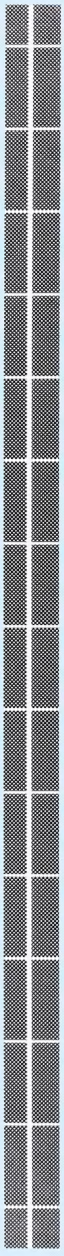
The Sources

In Alberta, the major sources of sulphur oxides are natural gas processing, oil sands plants and coal-fired power plants. These are primary industries and integral to the province's economic structure. The major sources of nitrogen oxides are automobile exhaust, and industrial activities ranging from the operations of the petroleum industry to electric utilities to fertilizer, cement, chemical and pulp and paper industries.

Global warming, discussed in the fact sheet *Greenhouse Effect*, may increase the amount of acid deposited, because warmer temperatures stimulate many of the acid-forming processes.



pH Scale



0 **ACIDIC**

1

lemon juice

2

vinegar

3

4

5

typical Alberta rain

6

milk

7 **NEUTRAL**

baking soda

8

9

10

milk of magnesia

11

12 ammonia

13

14 **ALKALINE**

The Effects

The effects of acid deposition on lakes and forests, crops, materials (such as barbed-wire fences) and buildings have been documented around the world.

For emissions to cause damage to the ecosystem two factors must prevail:

- there must be sensitive ecosystems downwind of the source
- weather patterns must be such that they will transport the pollutants to the sensitive area allowing enough time (and distance) for the chemical transformations to occur.

When these conditions prevail, acid deposition can have the following effects. Agricultural crops can be damaged directly or by reduced soil fertility. Forest growth can be retarded and leaves and needles damaged. Long-term exposure to acid deposition can lower the pH of lakes and streams, making them more acidic, affecting everything that drinks or lives in these waters and eventually killing the fish. Acid deposition causes metals, some of them toxic, to leach out of the soil and accumulate in water and in the food chain. The acidic particles transported in weather systems not only reduce visibility, they can impair lung functions and affect breathing. Acid deposition also affects buildings; it erodes stone, brick and concrete and it corrodes metals. The crumbling of the Parthenon in Greece is a well-known example of this environmental damage.

What Has Been Done So Far?

Over the last decade work has been done to quantify and evaluate the situation. In 1980 the Western and Northern Canada Long Range Transport of Air Pollutants (LRTAP) program was established to investigate the long-range transport of air pollutants and their possible environmental effects. Sensitive areas were mapped, depositions monitored and emissions inventoried. The work of LRTAP is still continuing.

In 1983, the Acid Deposition Research Program (ADRP), a joint project of the Alberta government and the energy industry, was set up to determine if there were problems with acid deposition on Alberta's crops, forests, soils, streams and lakes. No regional scale impacts were reported; but there was a warning that increased deposition could harm susceptible areas. The research, ongoing over several years, was designed to develop a comprehensive understanding and provides a scientific basis for sound, long-term management and regulatory control.

In the same year that ADRP began, Canadian provincial and federal environment ministries adopted a wet deposition objective – 20 kilograms per hectare per year – of sulphate in precipitation. Alberta's wet sulphate deposition is less than half that (nine kilograms per hectare) but in Western Canada, wet sulphate deposition is not a direct measure of wet acid deposition because alkaline dust and ammonia act to neutralize acidity and sulphate is present in the dust.

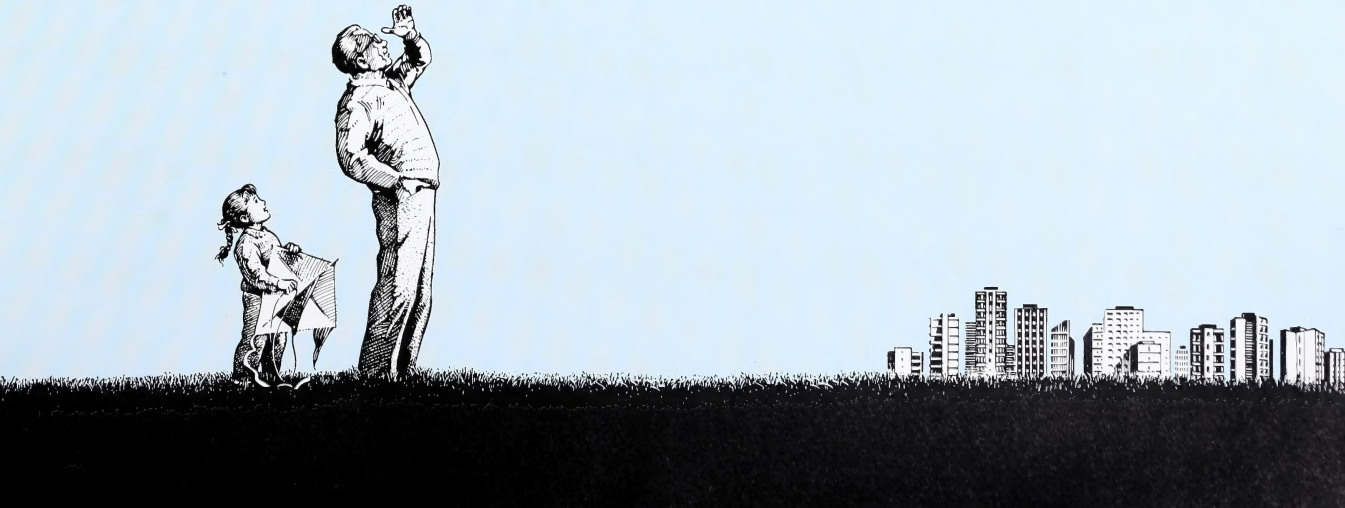
Dry deposition, which is more of a concern in Western Canada than in Eastern Canada, has not been as extensively studied and objectives to control it have not been set.

A 1988 study supervised by the National Research Council recommended that interim target loadings (deposition objectives) be developed while further research is conducted. This work is currently underway in the Western and Northern Canada Long Range Transport of Air Pollutants program.

The Future

To date acid deposition has not been a significant factor in Alberta, but scientists caution that increased industrialization may increase acid-forming emissions which could have an impact on the sensitive areas of the province.

The 1985 United Nations Economic Commission for Europe (UN-ECE) Protocol, which led to a 30 per cent reduction in sulphur dioxide (SO_2) emissions, is due for renegotiation in 1994.



Further Information

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Other information on acid deposition (acid rain):

- *Western and Northern Canada Long Range Transport of Air Pollutants Annual Report, 1988.*
- *The Acid Deposition Research Program Final Report, 1989.*
- *Focus on Acidic Deposition.*

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OZONE (O_3) – STRATOSPHERIC AND GROUND-LEVEL

What is Ozone?

Ozone gas (O_3) has a bluish colour and, at low concentration, smells like freshly cut hay. People often notice ozone in the sharp smell of electrical equipment or the clean smell after a thunderstorm. It is manufactured commercially by passing electricity through dry air or oxygen. Ozone is used to purify drinking water, eliminate odours, treat sewage, sterilize equipment and bleach inorganic products such as clays.

Ozone in the stratosphere and at ground level has become an important global air quality issue. The concern about ozone in the stratosphere is that it is depleting; the concern at ground level is that it is increasing.

Stratospheric

In the stratosphere (at altitudes of 15 to 35 km) the ozone layer acts as a natural filter absorbing most of the sun's damaging ultraviolet rays – those that burn skin and cause some forms of skin cancer. Hence the concern about the depleting ozone layer in the earth's upper atmosphere.

Ground Level

At ground level, ozone is a major component of photochemical smog which has a noticeable light brown colour and results in reduced visibility and health concerns. The term smog has been in use since 1905 when it was used to describe the smoke and fog in many Scottish cities. In the 1940s increased concentrations of ground-level ozone were observed in Los Angeles. The concern with tropospheric or ground-level ozone is its very presence, because as a component of smog it is a serious pollutant.

Sources

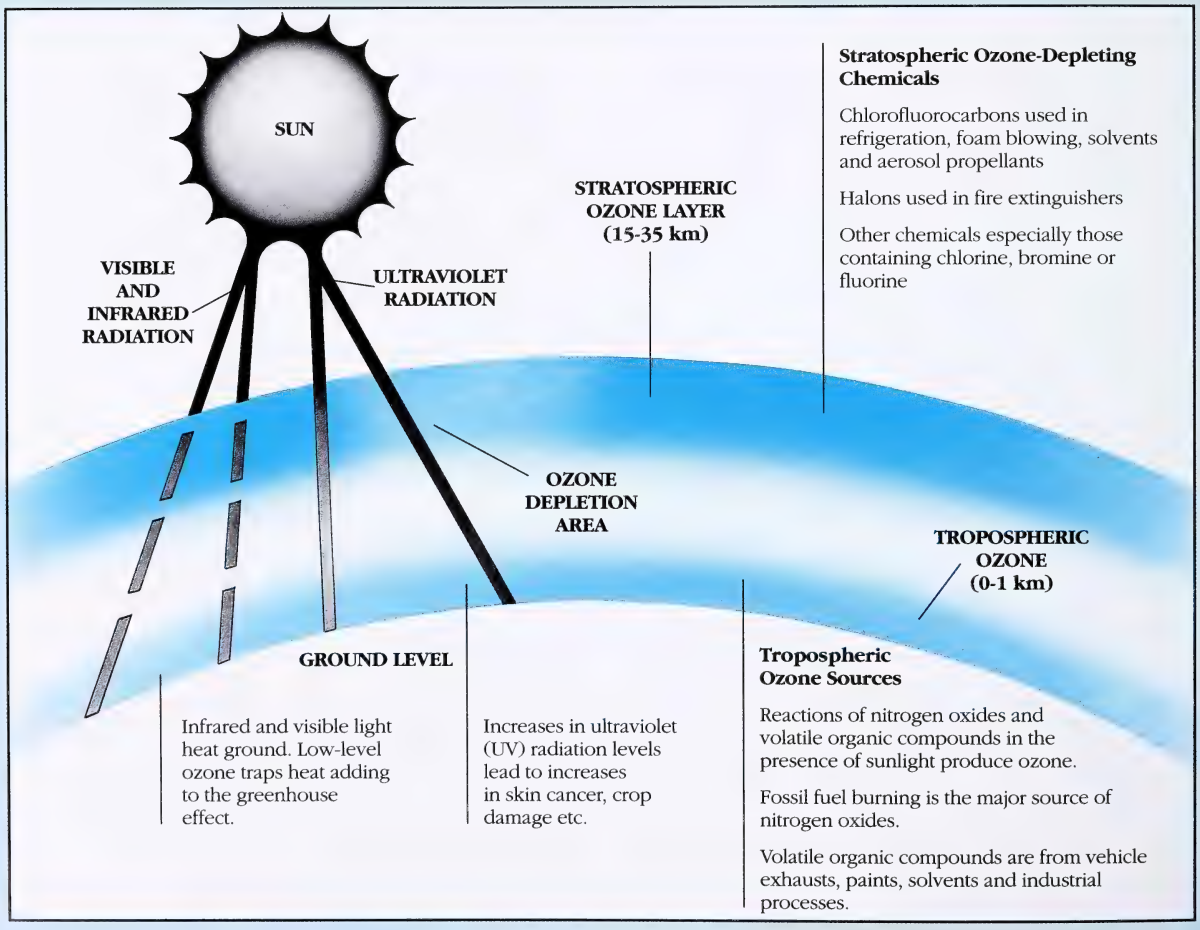
Stratospheric

In the stratosphere the protective natural layer of ozone is formed by oxygen (O_2) in the presence of ultraviolet radiation. Most of the ozone in the upper atmosphere is in a 20-kilometre-thick layer lying between 15 km to 35 km above the earth's surface. Even at this height, industrial pollutants are reaching and depleting the ozone. The major ozone-depleting substances are chlorofluorocarbons (CFCs), halons, methane (CH_4) and nitrous oxide (N_2O). Chlorofluorocarbons are used in refrigeration, foam blowing, solvents and specialized aerosol propellants. Halons are similar to chlorofluorocarbons and are used in fire extinguishers. Methane is a product of agricultural, industrial and mining activities while nitrous oxide is from combustion and fertilizer use. These gases are discussed in other fact sheets.

Ground Level

At ground level, ozone is formed when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight. The fact sheets *Nitrogen Oxides (NO_x)* and *Volatile Organic Compounds (VOCs)* give further details. Burning of fossil fuels is a major man-made cause of nitrogen oxides, while use of motor vehicles, solvents, and industrial processes in the petrochemical industry are sources of volatile organic compounds. These man-made emissions are more concentrated in urban and industrialized areas.

Some ground-level ozone is actually transported down from the stratosphere; some comes from reactions of naturally occurring volatile organic compounds and nitrogen oxides in sunlight.



The Effects

Stratospheric

In the stratosphere the ozone layer absorbs and filters the sun's ultraviolet rays, protecting the earth from harmful radiation. Scientists report a thinning of this shield. In some areas, such as in the Antarctic, "holes" have appeared. As the ozone shield thins, more ultraviolet rays will penetrate causing a variety of concerns. Many crops, including most of the world's major food sources – wheat, rice, corn and soya beans – are particularly sensitive to ultraviolet radiation and will be damaged.

In the oceans, aquatic life near the surface, including fish, will be damaged. Even industrial materials such as plastics and paints are susceptible, becoming yellow and brittle. Increased ultraviolet radiation affects humans too, causing sunburn, skin cancer, eye aging and suppression of the immune system. If stratospheric ozone is depleted, more ultraviolet radiation will reach ground level to add to and increase undesirable ground-level ozone and photochemical smog.

Ground Level

Smog has wide-ranging effects. This brown haze has the greatest impact on the air quality in urban areas. It can affect human health and corrode buildings and machinery. Smog produces eye, nose and throat irritations and in the short term can cause coughing, chest pain and other respiratory discomforts. Over the long term, continuous exposure to ground-level ozone can damage lung tissue and contribute to chronic lung disease and reduce life expectancy.

Agricultural crops such as wheat, alfalfa, corn and beans are also prone to damage from smog when concentrations are consistently above the Canadian objective level. Leaves are damaged and growth reduced; susceptibility to insects and disease increases. Smog also accelerates the deterioration of rubber products.

Ground-level ozone is a greenhouse gas and part of the complex inter-relationship affecting air quality. Higher concentrations will contribute to global warming and, in time, a warmer climate might lead to even greater ozone production.

What Has Been Done So Far?

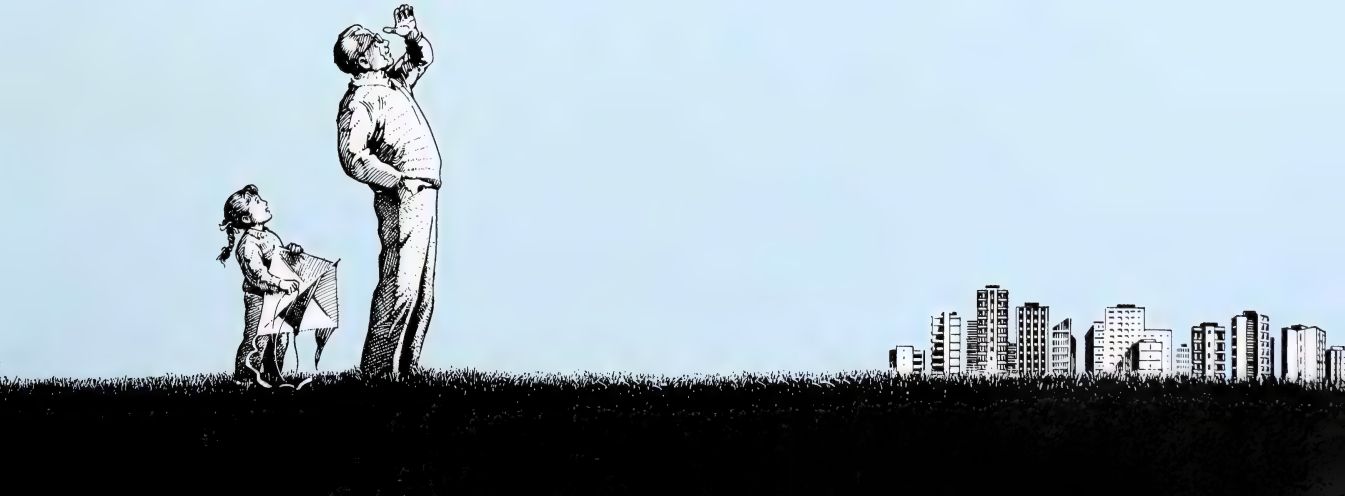
Stratospheric

The fact sheet *Chlorofluorocarbons (CFCs) and Halons* outlines steps taken to reduce chlorofluorocarbons to help prevent depletion of the stratospheric ozone layer.

Ground Level

Canada and Alberta have set ambient air quality objectives for ground-level ozone at 82 parts per billion by volume (ppbv) over one hour while the objectives in the United States are 120 ppbv. The fact sheets *Nitrogen Oxides (NO_x)* and *Volatile Organic Compounds (VOCs)* refer to Canada's *NO_x/VOC Management Plan* which has as its goal reducing ground-level ozone concentration to meet the 82 ppbv objective on a consistent basis.

That plan indicates the Canadian objective was exceeded an average of 16.8 days a year in Windsor, Ontario; 15.4 days in Toronto, Ontario; seven days in Vancouver, British Columbia; 5.5 days in St. John, New Brunswick; one day in Calgary and two days a year in Edmonton. These measurements are an average taken over the years 1982 to 1986.



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Glossary

Other information on ozone (O_3) and smog:

- *Management Plan for Nitrogen Oxides and Volatile Organic Compounds*. First Edition, Draft. March 1990. (Summary)
- *Focus on Ozone Depletion*.

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CARBON DIOXIDE (CO_2)

What is Carbon Dioxide?

Carbon dioxide (CO_2) is a colourless, odourless, non-toxic gas that in its solid form is known as "dry ice". Carbon dioxide is used commercially in fire extinguishers and to carbonate beverages. While carbon dioxide occurs naturally, it is the most common of the man-made greenhouse gases and is believed to be a significant contributor to global warming. The fact sheet *Greenhouse Effect* has more information on global warming.

Sources

Carbon dioxide is produced when any substance containing carbon is burned. It is also a product of breathing and of fermentation. Plants absorb carbon dioxide through photosynthesis, and plants and soil return some carbon dioxide to the atmosphere through respiration. A similar transfer takes place in the oceans, with absorption being slightly greater than what is released.

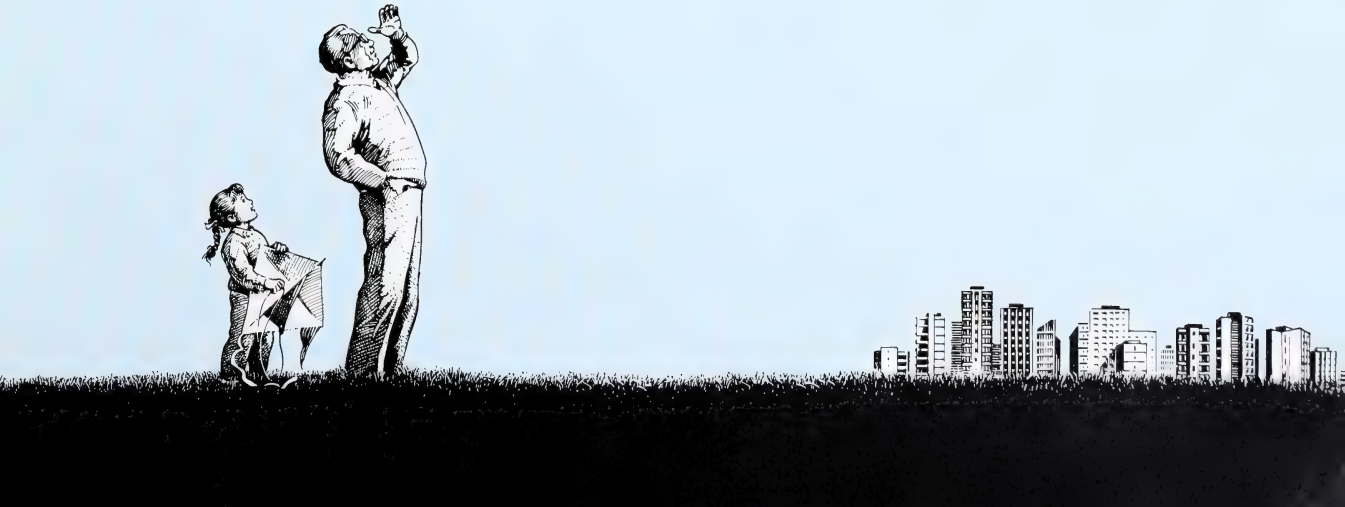
However, man-made carbon dioxide emissions have created an imbalance. There are now more carbon dioxide emissions going into the atmosphere than are being removed. This is primarily due to the burning of fossil fuel.

Although Canada produces only two per cent of the world's energy-related carbon dioxide emissions, it is one of the world's highest emitters on a per capita basis. Canada's cold climate, long transportation distances and energy-intensive export industries all contribute to this level of carbon dioxide emissions.

When emissions of carbon dioxide per unit of Gross Domestic Product are compared, Canada's record is similar to many other industrialized countries. Within Canada, Alberta is the largest per capita emitter of carbon dioxide and produces 22 per cent of the Canadian total.

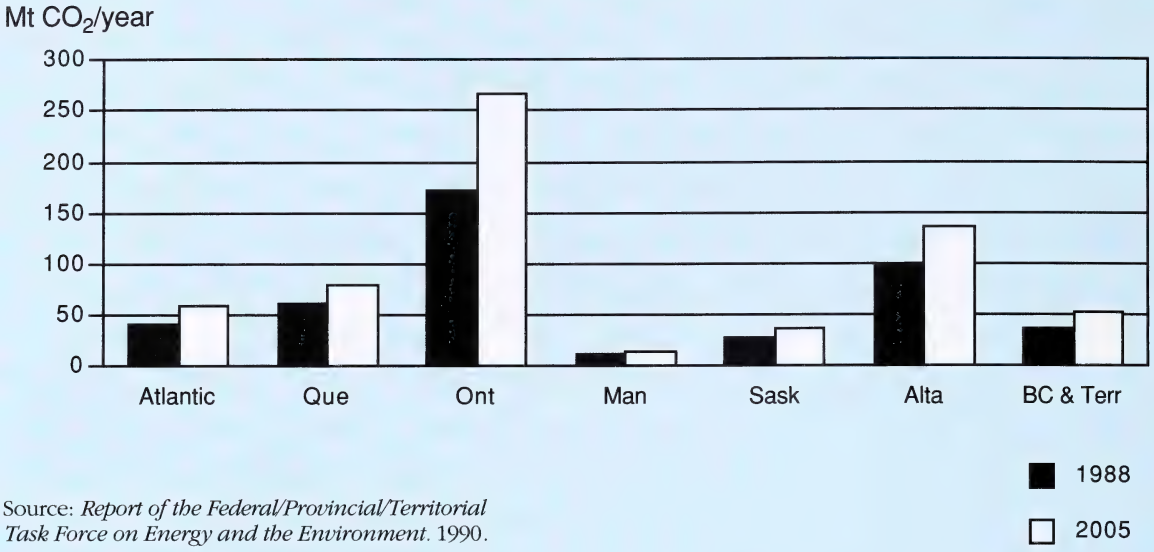
The oil and gas industry – gas processing, oil sands, pipelines and refineries – is responsible for about one-third of Alberta's man-made carbon dioxide emissions. Coal-generated electricity is responsible for another one-third and the final one-third is from the end use of energy in business, industry, homes and transportation.

But Alberta's carbon dioxide emissions are not all from products consumed by Albertans. At least three-quarters of the carbon dioxide from the energy industry is associated with the production of oil and gas exported from Alberta for use in other provinces and the United States.



Carbon Dioxide (CO_2) Emissions by Province

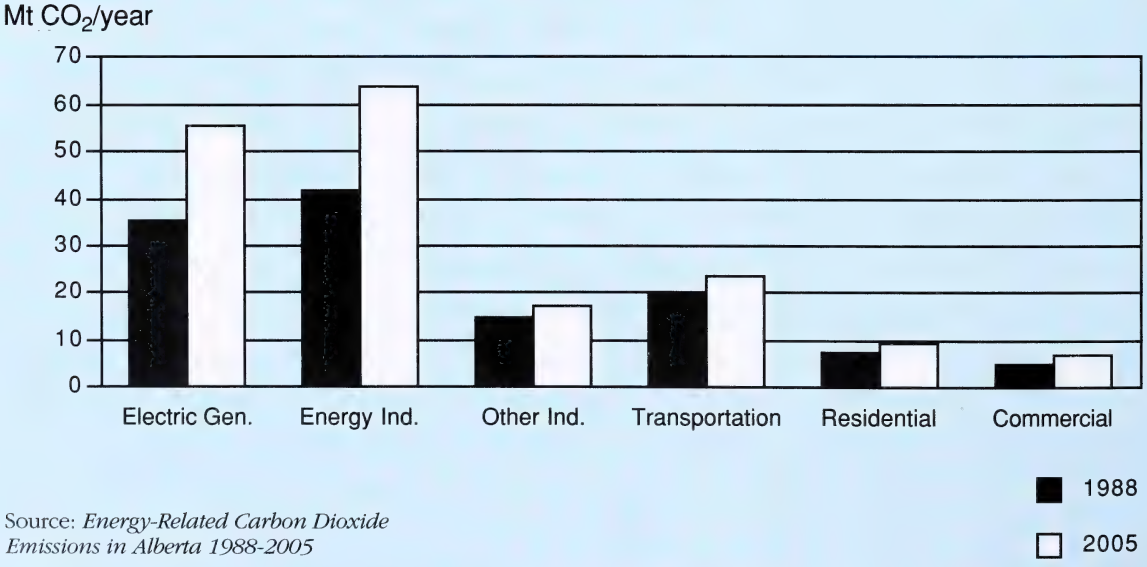
(in Megatonnes/year)



Source: *Report of the Federal/Provincial/Territorial Task Force on Energy and the Environment*. 1990.

Alberta Carbon Dioxide (CO_2) Emissions

(in Megatonnes/year)



Source: *Energy-Related Carbon Dioxide Emissions in Alberta 1988-2005*

Effects

The contribution of excessive amounts of carbon dioxide to the greenhouse effect is a major concern. The fact sheet *Greenhouse Effect* discusses how this could lead to global warming, and in turn have an impact on food production, fresh water supplies, forest and land use and sea levels. There is some concern that vegetation zones may shift; for example, a forest area may be replaced by grasslands.

Because plants require carbon dioxide for growth, some scientists believe that an increase in emissions could lead to increased growth, as long as sufficient water and sunlight are available. Others believe this effect would be countered by the severity of weather extremes associated with global warming.

What Has Been Done So Far?

In June 1988, the international Changing Atmosphere Conference held in Toronto, recommended reducing carbon dioxide emissions to 80 per cent of 1988 levels by the year 2005.

In April 1990, the Federal/Provincial/Territorial Task Force on Energy and the Environment concluded that, based on current forecasts of energy growth, the proposed 20 per cent cut would, in fact, be a reduction by 47 per cent of the projected 2005 levels. The task force concluded that level of reduction would be extremely difficult to achieve without significant changes in lifestyle. The task force felt consultation with energy producers and consumers was essential before governments set reduction targets. It noted that many cost-effective reduction measures are possible through energy conservation, improved energy efficiency and fuel substitution. Slowing down increasing demands for energy would have a significant effect.

At the international level, carbon dioxide reduction protocols are being discussed through the United Nation's Inter-governmental Panel on Climate Change.

The Future

The federal government has plans to participate in the development of international protocols to reduce impacts on the global climate. In collaboration with other nations, Canada will work to develop specific protocols on such subjects as reducing carbon dioxide emissions. This work will be reviewed in June 1992 at the Brazil Conference on Environment and Development, and may result in the signing of a convention on climate change.

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Other information on carbon dioxide (CO_2):

Energy-Related Carbon Dioxide Emissions in Alberta 1988-2005

Report of the Federal/Provincial/Territorial Task Force on Energy and the Environment. April 1990

A Discussion Paper on the Potential for Reducing Carbon Dioxide Emissions in Alberta, 1988-2005. Alberta Energy. August 1990.

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SULPHUR OXIDES (SO_x)

What are Sulphur Oxides?

SO_x refers to all sulphur oxides, the two major ones being sulphur dioxide (SO_2) and sulphur trioxide (SO_3). Sulphur dioxide is a colourless gas with a pungent, irritating odour and taste. It is highly soluble in water forming weakly acidic sulphurous acid. When sulphur dioxide combines with the oxygen (O_2) in the air some sulphur trioxide is slowly formed. Sulphur trioxide rapidly combines with water to produce sulphuric acid. The lifespan of sulphur oxides in the atmosphere is from four to 10 days.

Sulphur dioxide is used in many industrial processes such as chemical preparation, refining, pulp-making and solvent extraction. Sulphur dioxide is also used in the preparation and preservation of food because it prevents bacterial growth and the browning of fruit.

Sources

Natural sources of sulphur dioxide include volcanoes and hot springs. Sulphur dioxide is also formed by the oxidation of hydrogen sulphide (H_2S), a toxic gas that smells like rotten eggs. Oxidation occurs when hydrogen sulphide combines with the oxygen in air. Hydrogen sulphide is released by marshes and other places on land and in oceans where biological decay is taking place. Hydrogen sulphide is frequently found with natural gas. These deposits are referred to as sour gas.

Man-made sources of sulphur dioxide include sour gas processing, oil sands production, coal combustion, ore refining, chemical manufacturing and other fossil fuel processing and burning.

Canada's sulphur dioxide emissions are about 15 per cent of those of the United States, and Alberta's emissions are about 15 per cent of Canada's.

Of the 626 kilotonnes of sulphur dioxide emitted in Alberta in 1988, sour gas plants accounted for 38 per cent, oil sands 29 per cent and coal-fired power plants 16 per cent. Sulphur trioxide is generally emitted with sulphur dioxide at about one to five per cent of the sulphur dioxide emission rate.

Effects

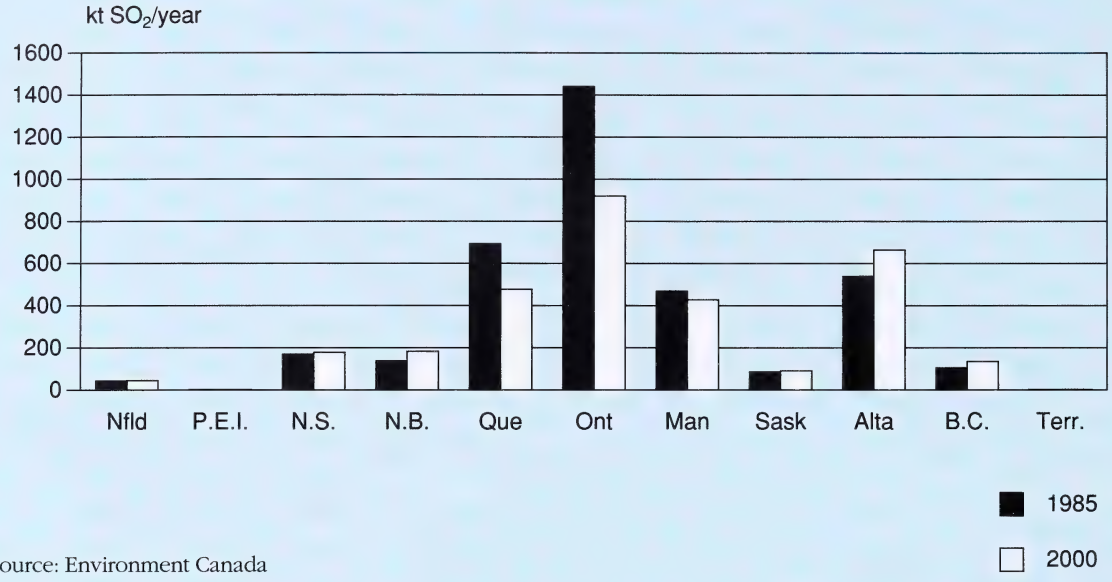
Sulphur dioxide can harm crops and trees, textiles, building materials, animals, and people either as a result of exposure to long-term low concentrations or short-term high concentrations. It turns leaves yellow and decreases the growth rate of crops. Sulphur dioxide corrodes metal, and causes building materials and textiles to deteriorate and weaken.

Sulphur dioxide irritates the throat and lungs and, if there are fine dust particles in the air, can damage a person's respiratory system. Sulphur oxides combine with other substances in the air to produce a haze that reduces visibility.

Sulphur dioxide is a major contributor to acid deposition, which is described in the fact sheet *Acid Deposition (Acid Rain)*.

Sulphur Dioxide (SO_2) Emissions by Province

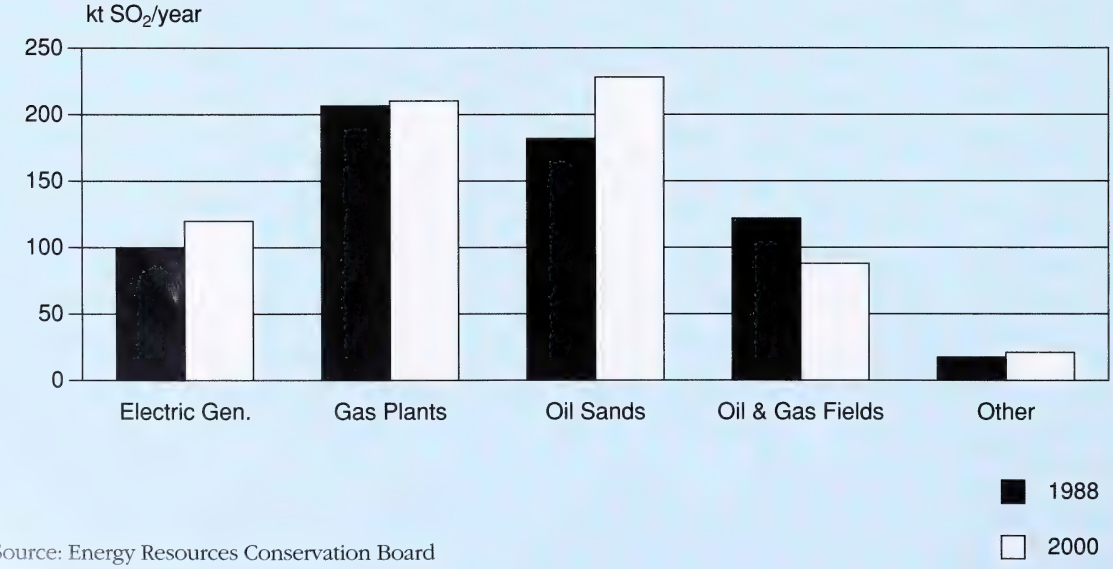
(In Kilotonnes/year)



Source: Environment Canada

Alberta Sulphur Dioxide (SO_2) Emissions

(In Kilotonnes/year)



Source: Energy Resources Conservation Board

What Has Been Done So Far?

Ambient objectives were set years ago by federal and provincial governments. The concentration of sulphur oxides in the air is carefully monitored regularly around facilities that emit sulphur oxides, and in some urban centres, to ensure those objectives are met. The Alberta objective for sulphur dioxide concentrations, averaged over one hour, is 0.17 parts per million (by volume) in air.

Alberta has had sulphur dioxide emission standards for gas processing plants since 1971. In August 1988, the Alberta government moved to further reduce the sulphur dioxide emissions produced by gas plants.

The new sulphur recovery guidelines require that for large new plants, 99.8 per cent of the sulphur be removed, up from the previous 96.2 per cent. Smaller gas plants must also provide sulphur recovery, ranging from 70 to 90 per cent. The new requirements are not applied to existing plants unless they expand by more than 25 per cent.

Alberta has adopted the national emission standards for new coal- or gas-fired power plants.

In 1985 Canada signed a United Nations Economic Commission for Europe (UN-ECE) protocol agreeing to a 30 per cent reduction in national sulphur dioxide emissions. In view of the substantial acid deposition problem in Eastern Canada, the reduction was implemented as a 50 per cent reduction in all provinces east of Saskatchewan.

The Future

The 1985 protocol, referred to above, is due for renegotiation in 1994.

Further Information

Air quality issues – greenhouse gases, acid deposition (acid rain) and smog – cannot be addressed in isolation. Their complex inter-relationships make achieving the goal of clean air for the future a challenge for individuals, industry and governments alike. The Clean Air Strategy for Alberta is providing an opportunity for Albertans to participate in meeting that challenge.

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Chlorofluorocarbons and Halons
Energy Efficiency
Policy Instruments
Glossary

Other information on sulphur oxides (SO_x):

Industrial Sulphur Dioxide Emissions Inventory for Alberta. 1981-1985. Alberta Environment. February 1988.

Sulphur Emissions Forecast for Alberta. Alberta Energy/Energy Resources Conservation Board, August 1990.

The above and additional information may be obtained by contacting:

Clean Air Strategy for Alberta
Bag One, Mail Room, Main Floor
North Tower, Petroleum Plaza
9945 - 108 Street
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(403) 427-9793 Fax: 427-2278

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METHANE (CH_4)

What is Methane?

Methane (CH_4) is a colourless, odourless, non-toxic and flammable gas, and is the most simple of the hydrocarbons. Mixed with certain proportions of air, it can be dangerously explosive. Methane is a greenhouse gas that occurs naturally and its production has kept pace with the world's population growth.

Sources

Methane is produced by the breakdown of plant materials in landfills, swamps and marshes. Digestion, rotting and incomplete burning all produce methane. Methane is found in oil, gas and coal deposits. Methane gas is also produced by livestock, other animals and humans. Natural processes contribute about one-half of the methane in the atmosphere; the rest comes from agriculture and the production of fossil fuels.

The chart on page two shows global methane emissions for 1988.

Numbers for Alberta are not available; however, an Alberta Environment-sponsored project at the University of Alberta is currently looking at methane and carbon dioxide (CO_2) emissions from Alberta's wetlands.

Effects

Methane is a greenhouse gas that contributes to potential global warming. Although there is less methane in the atmosphere than there is carbon dioxide, methane is about 20 times more potent over a 100-year period. Global warming is discussed in the fact sheet *Greenhouse Effect.*

Methane has a long lifespan in the atmosphere and also contributes to the depletion of the ozone layer in the stratosphere. Through chemical reactions, involving nitrogen oxides (NO_x), it also contributes to the production of ground-level ozone (O_3). For more information see the fact sheet *Ozone – Stratospheric and Ground-Level.*

What Has Been Done So Far?

By reducing emissions of volatile organic compounds (see the fact sheet *Volatile Organic Compounds*), methane emissions are also reduced. Steps have already been taken to reduce methane emissions. Among the reduction measures are methane collection systems at some coal mines and landfill sites, energy efficiency improvements, and pollution control equipment on vehicles.

Global Annual Methane (CH_4) Emissions

Source	*Megatonnes CH_4*
Wetlands	115
Rice Paddies	110
Enteric Fermentation*	80
Biomass Burning	55
Gas drilling, venting, and transmission	45**
Termites	40
Landfills	40
Coal Mining	35
Oceans	10
Freshwaters	5
Methane Hydrate Destabilization	5
Total	540

Source: Cicerone and Oremland, 1988

one megatonne = one million metric tonnes = 10^9 kilograms

* Intestinal fermentation.

** This number assumes 3.4 per cent losses in the natural gas industry. CGA/NOVA estimates Canada's average losses at 0.36 per cent (worst case).

Further Information

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NITROGEN OXIDES (NO_x)

What are Nitrogen Oxides?

Nitrogen oxides (NO_x) consist of nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O) and are formed when nitrogen (N_2) combines with oxygen (O_2). Their lifespans in the atmosphere range from one to seven days for nitric oxide and nitrogen dioxide, to 170 years for nitrous oxide.

Nitric oxide has no colour, odour, or taste and is non-toxic. In the air it is rapidly oxidized to nitrogen dioxide.

Nitrogen dioxide is a reddish-brown gas with a pungent, irritating odour. It absorbs light and leads to the yellow-brown haze sometimes seen hanging over cities. It is one of the important components of smog.

Nitrous oxide is a colourless, slightly sweet-smelling, non-toxic gas which occurs naturally in the atmosphere. Man-made nitrous oxide is used as the anaesthetic commonly called "laughing gas".

Sources

Nitrogen oxides occur naturally and also are produced by man's activities. In nature, they are a result of bacterial processes, biological growth and decay, lightning, and forest and grassland fires. The primary source of man-made nitrogen oxides is from the burning of fossil fuels.

Of the nitrogen oxides emitted, most is nitric oxide, some is nitrous oxide and less than 10 per cent is nitrogen dioxide. The amount of nitrogen dioxide emitted varies with the temperature of combustion; as temperature increases so does the level of nitrogen dioxide. Agriculture also plays a role in nitrogen oxide emissions with the use of fertilizers contributing nitrous oxide to the atmosphere.

Alberta contributes about 23 per cent of the 1887 kilotonnes of nitrogen oxides emitted annually in Canada.

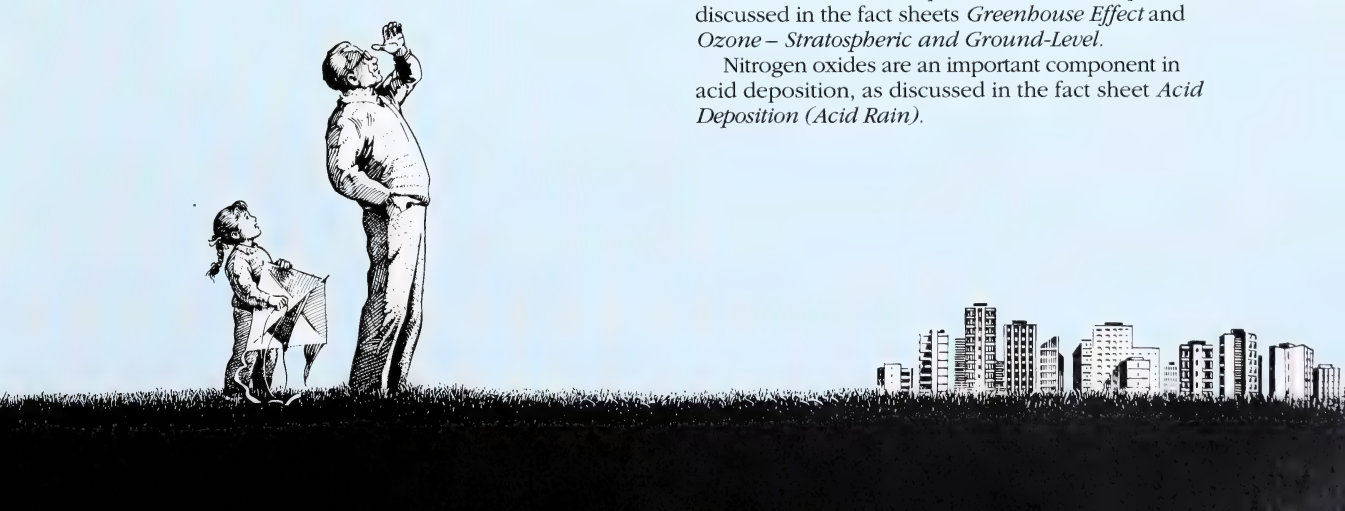
In Alberta the oil and gas industry is responsible for about 41 per cent of nitrogen oxide emissions, transportation (including planes, trains and automobiles) 25 per cent, electrical utilities 17 per cent, and other industrial, commercial and residential users the remaining 17 per cent.

Effects

Nitric oxide by itself is non-toxic, but it is readily converted in the air to nitrogen dioxide. At high concentration levels, nitrogen dioxide is potentially toxic to plants, can injure leaves and reduce growth and yield. In combination with either ozone (O_3) or sulphur dioxide (SO_2), nitrogen dioxide may cause injury at even lower concentration levels. As one of the components of smog, nitrogen dioxide is known to irritate the lungs and increase susceptibility to respiratory infections.

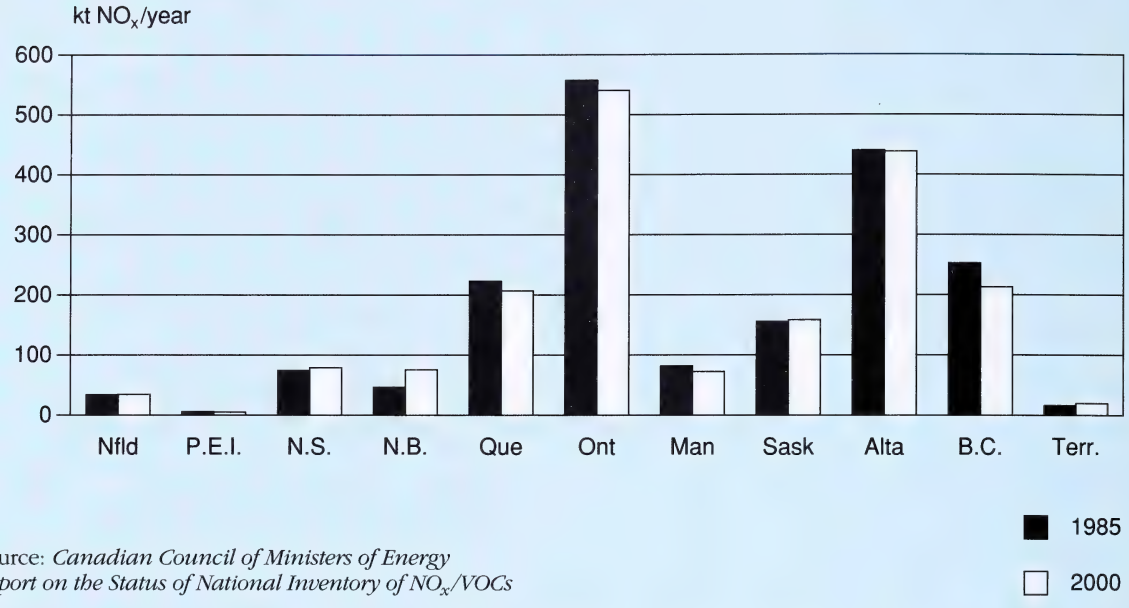
Nitrous oxide is a greenhouse gas. As well it contributes to ozone depletion in the stratosphere, as discussed in the fact sheets *Greenhouse Effect* and *Ozone – Stratospheric and Ground-Level.*

Nitrogen oxides are an important component in acid deposition, as discussed in the fact sheet *Acid Deposition (Acid Rain).*



Nitrogen Oxides (NO_x) Emissions by Province

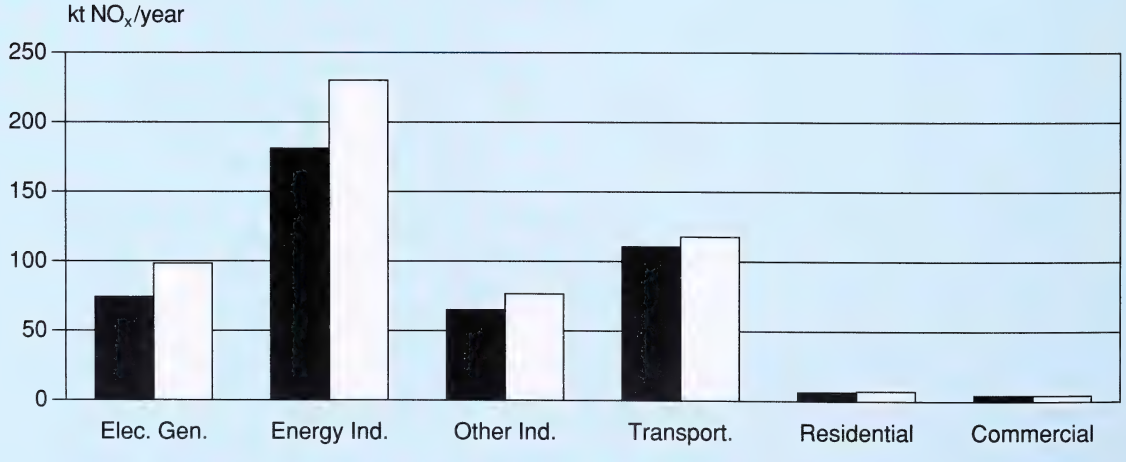
(In Kilotonnes/year)



Source: *Canadian Council of Ministers of Energy*
Report on the Status of National Inventory of NO_x/VOCs

Alberta Nitrogen Oxides (NO_x) Emissions

(In Kilotonnes/year)



Source: *Energy-Related Nitrogen Oxide Emissions in Alberta 1988-2005*

What Has Been Done So Far

Air quality objectives for nitrogen dioxide were set many years ago by the federal and provincial governments. The objective for nitrogen dioxide concentrations, averaged over one hour, is 0.21 parts per million (by volume) in air. The concentration of nitric oxide and nitrogen dioxide in the air is carefully monitored on a regular basis.

During the years 1985 to 1989 Calgary exceeded the air quality objective for nitrogen dioxide four times. Edmonton, Fort Saskatchewan and Fort McMurray did not exceed the objective.

National emission guidelines for new power plants were adopted in 1981. In 1988 Alberta required that all new natural gas-fired compressor engines use low nitrogen oxides technology. These engines produce about one-quarter of the emissions of older engines.

In 1988, Canada and 24 other countries signed a United Nations Economic Commission for Europe (UN-ECE) protocol agreeing to freeze nitrogen oxides emissions at the 1987 level and to accomplish this by 1994.

The Canadian Council of Ministers of the Environment (CCME) subsequently asked for a comprehensive plan to further manage nitrogen oxides and volatile organic compounds (VOCs) emissions to the year 2005. Following a national workshop in 1989, a draft *Management Plan for NO_x and VOCs* was published in March 1990. A second workshop was held in April 1990 and the first edition of the plan is expected by October 1990. A second edition of the plan, describing Canada's progress, is to be published in 1995.

One measure proposed by CCME to limit nitrogen oxides emissions is the adoption of proposed California auto emission standards, the most stringent in the world. If implemented, by 1994 all new cars sold in Canada would have to meet these standards.

Further Information

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Management Plan for Nitrogen Oxides and Volatile Organic Compounds. First Edition, Draft. March 1990. (Summary).

Nitrogen Oxides Emissions for Alberta 1987. Alberta Environment. February 1990.

Energy-Related Nitrogen Oxide Emissions in Alberta 1988-2005. Draft. Energy Resources Conservation Board / Alberta Environment. August 1990.

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VOLATILE ORGANIC COMPOUNDS (VOCs)

What Are Volatile Organic Compounds?

Chemicals containing hydrogen (H), carbon (C) and possibly other elements, that evaporate easily, are known (with the exception of methane (CH_4) which is discussed in the fact sheet *Methane (CH_4)*) as volatile organic compounds. Many hundreds of these compounds are present in the atmosphere.

In the presence of sunlight and nitrogen oxides (NO_x), volatile organic compounds react to form ground-level ozone (O_3), a component of smog. For more information see the fact sheet *Ozone – Stratospheric and Ground-Level*.

Sources

Fossil fuel deposits, including oil sands, are natural sources of volatile organic compounds, as are volcanoes, vegetation and bacteria. Trees also emit different volatile organic compounds. For example, deciduous trees emit great amounts of the compound isoprene during a hot day; coniferous trees emit the volatile organic compound pinene day and night.

Man-made volatile organic compound emissions come from transportation, solvent use, industrial processes and gasoline evaporation. Gasoline evaporation can occur when vehicles are being filled at service stations or when transfers of gasoline are made. Others are released when oil-based paints are applied or cleaning solvents are used.

Alberta is the fourth largest volatile organic compound emitting province in Canada. The dominant sources of man-made volatile organic compounds in Alberta are motor vehicles, petrochemical processes and the use of solvents.

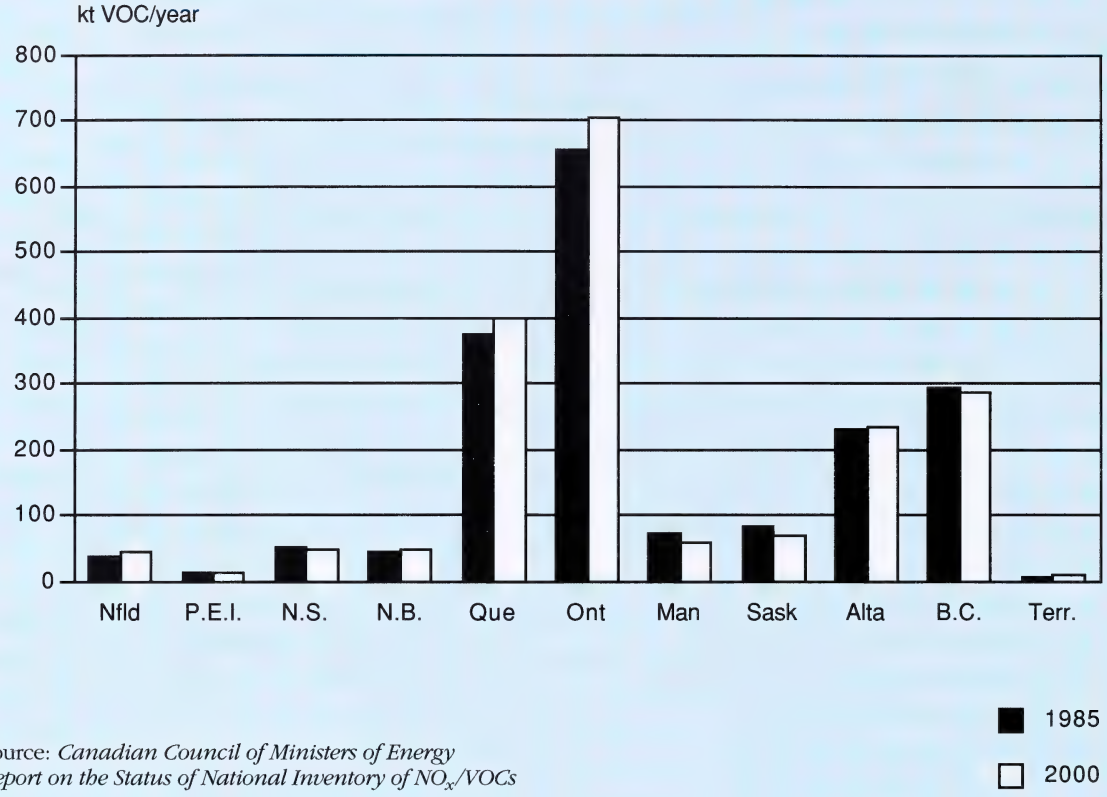
According to Environment Canada, the sources and percentage amounts of man-made volatile organic compounds generated in Alberta in 1985, were:

transportation	45.0%
petroleum and petrochemical industry	26.0%
solvents, coatings and miscellaneous sources	19.0%
fuel marketing (gasoline transfers from refinery to bulk stations, bulk stations to gas stations, gas stations to vehicles)	6.0%
electrical power generation	0.3%
all other	3.7%

This accounted for 229.2 kilotonnes of volatile organic compounds. In the same year, volatile organic compound emissions from natural sources (mainly trees) were estimated to be 890 kilotonnes.

Volatile Organic Compound (VOC) Emissions by Province

(In Kilotonnes/year)



Source: *Canadian Council of Ministers of Energy*
Report on the Status of National Inventory of NO_x/VOCs

The Effects

In the presence of sunlight, volatile organic compounds and nitrogen oxides react to produce ground-level ozone and other compounds. This contributes to the smog-related concerns described in fact sheet *Ozone – Stratospheric and Ground-Level.*

Some individual volatile organic compounds are believed to be a threat to human health. For example, benzene has been implicated as cancer-causing and hexane as a cause of nervous system disorders. The toxicity of a number of volatile organic compounds on the Priorities Substances List is currently being studied under the Canadian Environmental Protection Act.

What Has Been Done So Far?

At the October 1989 meeting of the Canadian Council of Ministers of the Environment (CCME) it was agreed to:

- reduce gasoline volatility.
- establish systems to recover VOC-containing vapours during gasoline distribution and sales.
- establish vehicle inspection and maintenance programs in areas where ground-level ozone is a problem.

CCME directed that a comprehensive plan to manage nitrogen oxides and volatile organic compound emissions be developed to further control emissions to the year 2005. Following a national workshop in 1989, a draft *Management Plan for NO_x and VOCs* was published in March 1990. A second workshop was held in April 1990 and the first edition of the plan is expected by October 1990. A second edition describing Canada's progress is to be published in 1995.

Further Information

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CHLOROFLUOROCARBONS (CFCs) AND HALONS

What are Chlorofluorocarbons and Halons?

Chlorofluorocarbons (CFCs) and halons are man-made chemicals that exist as gases or liquids. Chlorofluorocarbons contain chlorine, fluorine and carbon. Halons are similar but contain bromine or iodine. They are neither toxic nor flammable.

They were first manufactured in 1930 under the trademark Freon. Chlorofluorocarbons and halons have lifespans in the atmosphere of 60 to 110 years.

Sources

They do not occur naturally; they are always manufactured. They are currently used as coolants in industrial, home and automobile refrigeration and air conditioning, foaming agents and cleaning solvents. In the past they were commonly used as propellants in aerosol cans. Halons are used in special-purpose fire extinguishers and protection systems in such areas as computer rooms and electronic areas.

The chart on page two shows how chlorofluorocarbons were used in Canada in 1986.

Canada is responsible for less than three per cent of global chlorofluorocarbon use; and of those used in Canada in 1986, Alberta used about 10 per cent or 2000 tonnes.

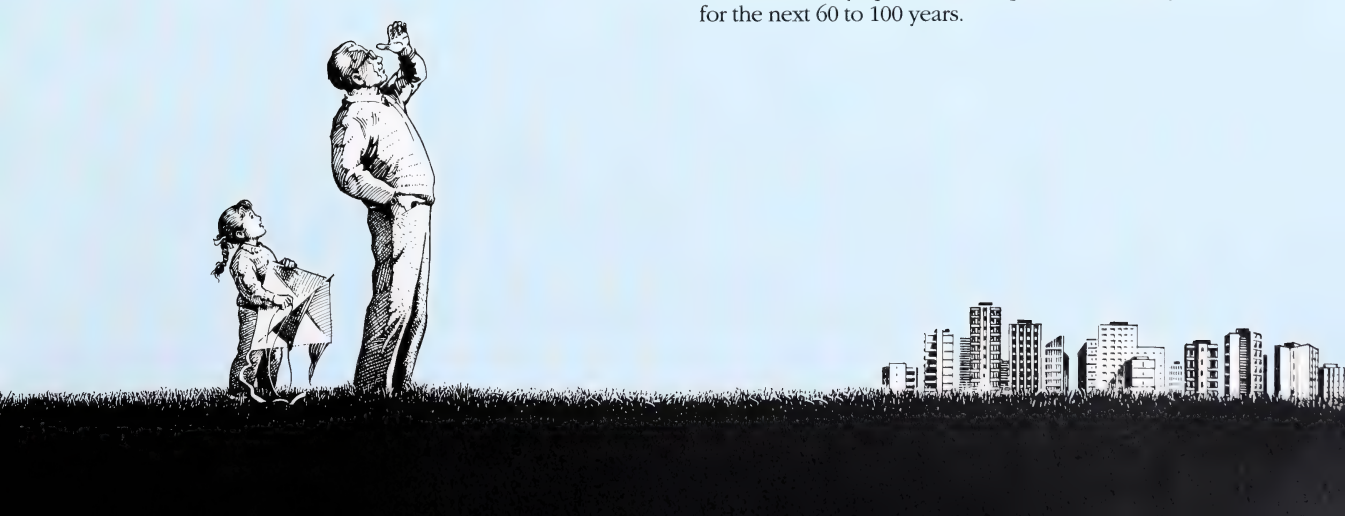
The Effects

Chlorofluorocarbons have two major, different – and often confused – effects in the atmosphere.

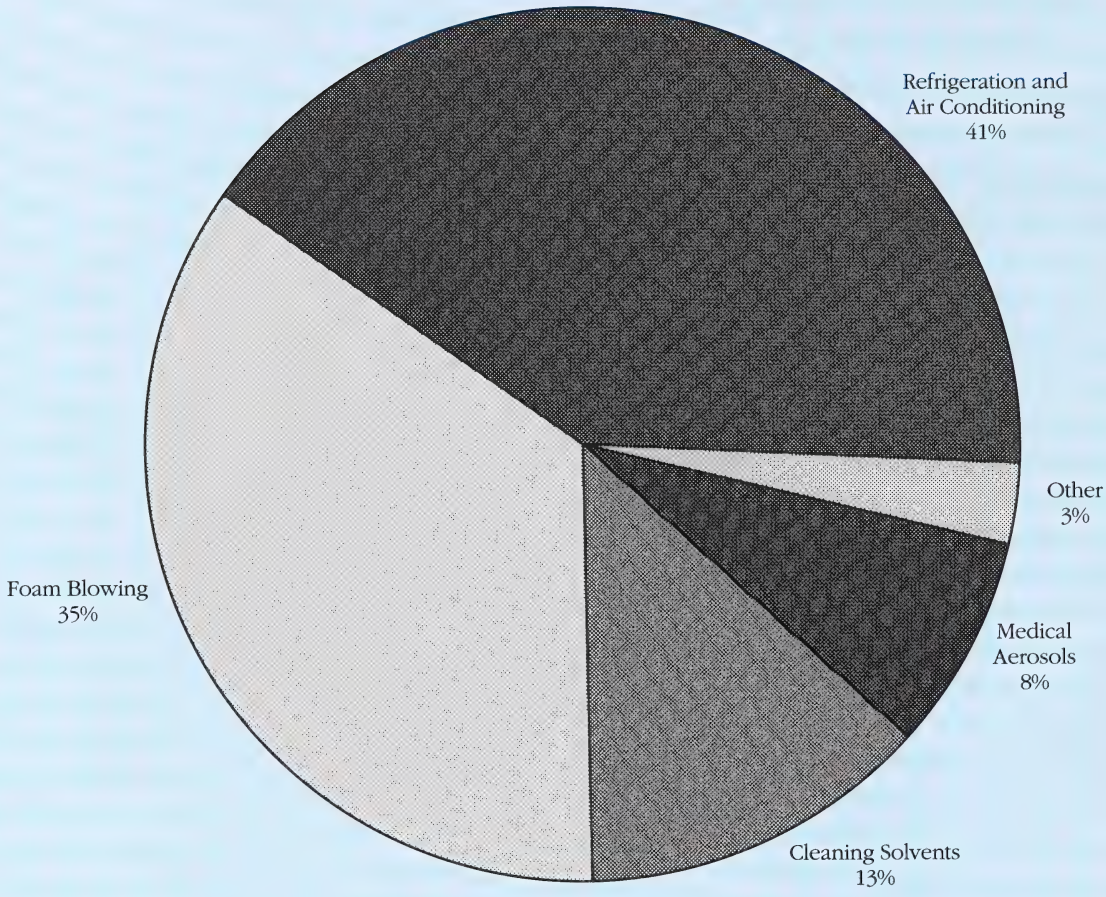
1. Greenhouse effect: chlorofluorocarbons and halons act as greenhouse gases and are considered major contributors to the concerns discussed in the fact sheet *Greenhouse Effect.*

2. Ozone-depletion effect: chlorofluorocarbons and halons are not destroyed in the lower atmosphere but waft slowly upward toward the stratosphere where they finally break down. Each of the chlorine or bromine atoms released in that breakdown is capable of destroying tens of thousands of ozone (O_3) molecules – thus contributing to the thinning of the protective ozone layer.

Even though chlorofluorocarbons and halon emissions are being stopped today, the destruction of the stratospheric ozone layer will still continue, because chlorofluorocarbons and halons already released will move slowly up to the stratosphere and destroy ozone for the next 60 to 100 years.



Chlorofluorocarbons (CFCs) in Canada



Source: Alberta Environment

What Has Been Done So Far?

Internationally there is commitment to stop compounding the problem and to reduce the use of chlorofluorocarbons and other ozone-depleting substances. International discussions began in 1981 and led to the 1985 Vienna Convention which establishes monitoring and scientific assessment activities.

Most members of the international community (including Canada) agreed in 1987 to The Montreal Protocol on Substances that Deplete the Ozone Layer. It set a schedule for reducing use of chlorofluorocarbons and halons by 1999 to 50 per cent of the levels used in 1986. At a meeting in Helsinki in 1989, participating nations agreed to accelerate that timetable to 85 per cent reduction by 1999. More recently Canada announced that it was prepared to end their use by 1997 and urged other nations to agree to meet earlier targets.

Canada played a key role in the Vienna Convention and The Montreal Protocol, and is encouraging a national objective to completely eliminate ozone-depleting substances. Alberta supports the national objective and, in consultation with the federal government, is developing regulations and plans for the recovery, recycling and destruction of these substances.

Substitutes already have been found for certain uses of chlorofluorocarbons. In 1980 Canada banned their use as propellants in consumer items such as hair sprays, deodorants and antiperspirants. Major producers of polystyrene insulation were to switch to a chlorofluorocarbon substitute by the end of 1989 and the world's largest manufacturer of chlorofluorocarbons is to phase out their manufacture by the year 2000. A major automobile manufacturer has announced that it will equip its auto dealers with chlorofluorocarbon recovery and recycling systems for servicing vehicle air conditioners. Market responses are proceeding so quickly that the reductions proposed by The Montreal protocol will be exceeded.

Further Information

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The Montreal Protocol on Substances that Deplete the Ozone Layer. Final Act. 1987.

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ENERGY EFFICIENCY

What is Energy Efficiency?

In this province, most of our energy comes from fossil fuels – oil, gas, and coal. Energy efficiency is the wise and careful use of that energy. Energy efficiency is finding ways to reduce energy consumption while achieving the necessary results. Greater energy efficiency can be achieved by improving equipment, better energy management and better operational practices or a combination of approaches. It will take a conscious effort by all Albertans and may include lifestyle changes. Energy efficiency includes producing energy in the most efficient way possible, as well as using the energy end-products most efficiently or reducing the demand.

Who Uses Energy?

Large quantities of energy are measured in units called petajoules (PJ). To put the size of a petajoule in perspective, it is the energy content of 164,000 barrels of crude oil, or 1 billion cubic feet of natural gas. In 1988 Alberta used some 2064 petajoules – which translates into one of the highest per capita rates in Canada. This is due in part to the energy demands of the energy production industry itself. It takes a lot of energy to produce energy. Also Albertans, as other North Americans, have energy-intensive lifestyles.

All sectors of the economy use energy. Figure 1 shows how Alberta energy use is distributed and the increases that are forecast. In each sector, numerous opportunities exist for reductions through improved energy efficiency.

The energy industry currently uses approximately 778 PJ per year. Included are oil fields and refineries, oil sands, gas processing, coal mines, pipelines and gas flaring. The energy needs are almost entirely for the production, processing and delivery of Alberta's large oil, gas and coal resources. These resources are marketed within Alberta, throughout North America and offshore.

Other energy-intensive industries, such as the petrochemical, manufacturing and forest products industries, use about 529 PJ per year. Electricity generation, largely from coal-fired power plants, is actually the third largest category; however, this energy is used by, and is therefore allocated to, the individual end-use sectors shown in Figure 1.

The transportation sector uses 285 PJ; the residential sector, 228 PJ; and the commercial sector 208 PJ. Together these three sectors form more than a third of the Alberta total.

Figure 2 shows the fuels used to generate energy in each of the various sectors.

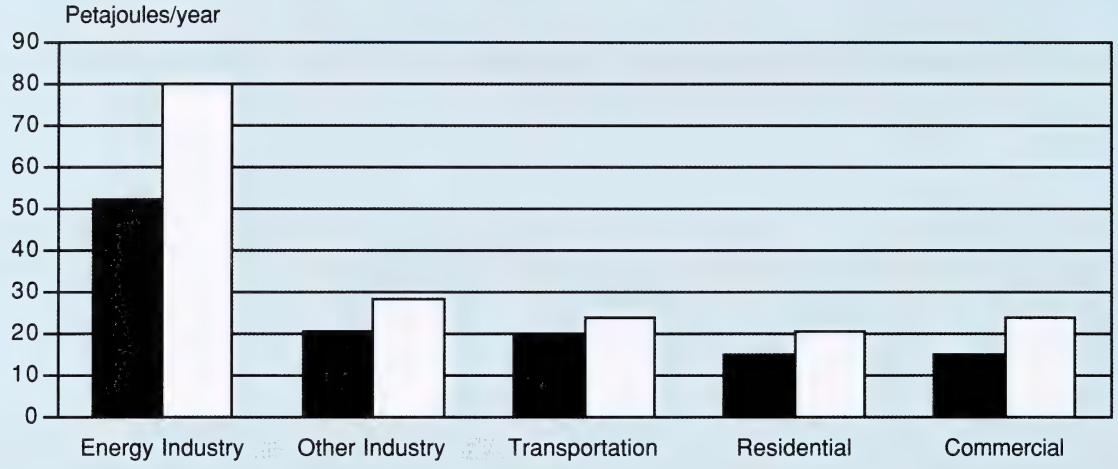
The Effects of Energy Efficiency

Energy efficiency has economic and environmental benefits.

Cost savings obtained through easily-implemented conservation and efficiency measures can be significant for companies, governments, organizations and individuals. Environmental benefits include a decrease in fossil fuel pollutants. For example, fossil fuel combustion produces emissions such as carbon dioxide (CO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs) and sulphur oxides (SO_x). Energy conservation achieved through efficiencies and demand reduction can cut these emissions significantly. This includes improving electricity end-use efficiency, as electric power in Alberta is generated primarily by burning fossil fuels.

*Figure 1 - Alberta's Energy Use by Sector**

(In Petajoules/year)

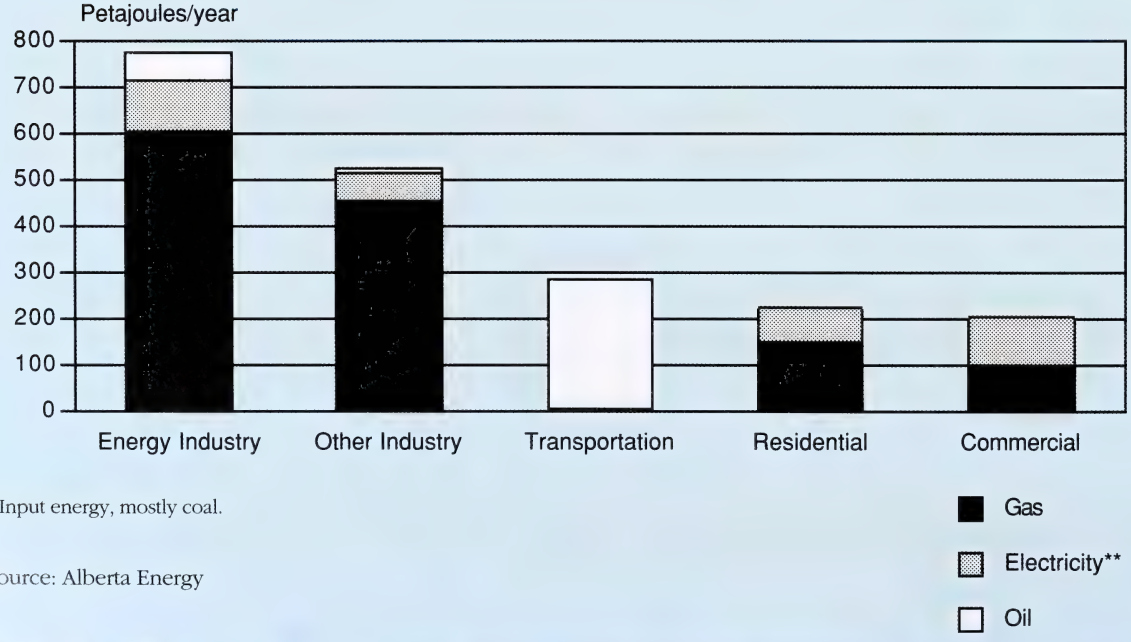


*Energy used to generate electricity has been allocated to each end-use sector.

Source: Alberta Energy

Figure 2 - Alberta's Energy Use by Fuel and Sector

(In Petajoules/year)



**Input energy, mostly coal.

Source: Alberta Energy

As well as reducing pollutants, energy conservation and efficiency delay the need to develop additional energy resources and sites for facilities for the transportation and conversion of the energy.

By using energy more efficiently, energy costs are reduced and so is the impact on the environment.

What Can Be Done To Increase Energy Efficiency?

There are many things that organizations and individuals can do to use energy more efficiently. Some measures apply only to specific sectors; other measures can be taken by everyone. Collectively these actions make a significant difference. For example, the Edmonton Public School Board has saved $10.2 million in fuel savings over a period of seven years through efficiency improvements. The City of Edmonton Parks and Recreation Department has seen energy efficiency improvements of up to 50 per cent in some of its facilities. Individuals frequently can improve residential energy efficiency by 25 per cent through conservation measures.

The Energy Efficiency Branch of the Alberta Department of Energy developed the following list of measures that can lead to improved energy use.

Residential

- Use a timer to lower thermostat setting at night and when building is unoccupied.
- Restrict hot water use, reduce water temperature and insulate tank.
- Use low-flow shower heads.
- Use high-efficiency, low-wattage bulbs and turn off lights when not needed.
- Improve air tightness with weatherstripping, caulking, air vapour seals.
- Insist on higher energy efficiency appliances
- Replace older furnaces with mid- or high-efficiency type.
- Keep vehicles well maintained.
- Select vehicles for fuel economy.
- Use public transit when possible, or car pool
- Use a timer for vehicle block heaters.

Commercial/Institutional

- Improve general housekeeping and maintenance to avoid waste.
- Control ventilation and equipment operating hours.
- Set back temperature when building is unoccupied.
- Ensure appropriate lighting type, ballast, wattage and usage.
- Install light switches in individual offices.
- Use low-flow shower heads.
- Insulate hot water tanks and loading doors.
- Use timer or power-saver cords on vehicle block heaters.
- Carefully control heating pump operation.
- Carefully control parkade temperature and ventilation.
- Improve weatherstripping
- Replace older appliances with high-efficiency type.
- Replace older furnaces with mid- or high-efficiency type.
- Install covers on swimming pools
- Take advantage of heat recovery on compressors, boiler stacks and ventilation
- Replace older motors with more energy-efficient type
- Use variable-speed motor controls
- Install de-stratification fans
- Look for opportunities for cogeneration from waste heat.

Energy Industry

- Make operational and maintenance improvements to avoid waste.
- Replace oversize motors.
- Ensure appropriate lighting type, ballast, wattage and usage.
- Improve engine efficiency.
- Improve efficiency of heaters and treaters.
- Allow for power factor correction.
- Make process equipment improvements.
- Make process changes.
- Make insulation repairs and improvements.
- Design heat recovery for furnace pre-heat and process use.
- Upgrade building insulation.
- Use better gas recovery methods.
- Look for opportunities for cogeneration from waste heat.
- Use variable-speed motor controls where appropriate.

Other Industry

- Make operations and maintenance improvements to avoid waste.
- Replace oversize motors.
- Ensure appropriate lighting type, ballast, wattage and usage.
- Schedule loads to best advantage.
- Allow for power factor correction.
- Make use of variable-speed drives.
- Insulate tanks, piping and equipment.
- Improve building heating and ventilation.
- Install a timer for vehicle block heaters.
- Recover heat for process use and building heating.
- Look for opportunities for cogeneration from waste heat.

Transportation

- Do systematic route planning and provide driver training.
- Maintain and retrofit vehicles for best efficiency.
- Consider fuel conversion alternatives.
- Select vehicles for fuel economy.
- Look at alternate means of transportation.
- Improve traffic management.
- Use timer or remote starters rather than let vehicles run in cold weather.
- Improve mass transit.

What Is Available To Encourage Energy Efficiency?

Energy efficiency is promoted through programs by government departments, Alberta's gas and electric utilities, environmental groups and private companies. Here are some examples.

Energy Efficiency Branch, Alberta Department of Energy

An energy audit service is available for business, industry and institutions which uses two computer-equipped Energy Buses. Audits are conducted at buildings, plants and for vehicle fleet operations, upon request and at no charge. Audits indicate how energy is being used and where there are opportunities for increased energy efficiencies. Accumulated results of energy audits are often used by consultants and others doing energy studies and proposals.

Publications are available on energy management and various technical topics. Presentations on the fundamentals of energy management are offered to interested groups.

Energy Matters is a free telephone enquiry service (427-5300 or Zenith 22339) that provides current information to the general public and businesses on energy efficiency and alternate energy for houses. Those building or renovating find it particularly useful.

How-to publications, with particular emphasis on incorporating energy efficiency into house construction and renovation, are distributed at no charge at building supply stores and utility and government offices. Audio-visual materials and workshops on energy efficiency in the home are available on request.

Teaching kits on energy efficiency and related topics are provided to schools. There are separate kits for each of the elementary grades and some for junior and senior high school levels. School visits are also made on request, and include skits which make the subject of saving energy fun as well as educational.

Fuel Economy Calculators are available free at gas stations throughout Alberta. These slide-rule calculators are a convenient way for motorists to record fuel purchases and determine their vehicle's fuel economy.

Driver Energy Conservation Awareness Training (DECAT) helps commercial drivers sharpen their skills in driving for fuel economy.

Research and Technology Branch, Alberta Department of Energy

Several publications are available on energy efficiency methods for residences and businesses.

The South-West Renewable Energy Initiative provides funding for renewable energy demonstration projects for the south-west region of Alberta. The program also has an office in the region to disseminate information on renewable energy to the public.

Alberta's Gas and Electric Utilities

The marketing, customer service and public affairs groups within utilities provide information on energy efficiency for homes.

Alberta Environmental Network

The Alberta Environmental Network Directory provides the names of environmental organizations that provide energy conservation advice.

Further Information

Air quality issues – greenhouse gases, acid deposition (acid rain) and smog – cannot be addressed in isolation. Their complex inter-relationships make achieving the goal of clean air for the future a challenge for individuals, industry and governments alike. The Clean Air Strategy for Alberta is providing an opportunity for Albertans to participate in meeting that challenge.

To assist Albertans in participating in the Clean Air Strategy for Alberta, the Alberta government has prepared a series of fact sheets and a glossary. Their purpose is to help Albertans understand the magnitude of the environmental and economic considerations, the complexity of the science, the potential requirement for changes in lifestyle, and the challenges facing individuals, industry and government.

Following is a list of these fact sheets along with instructions on how to obtain them.

An Overview
Greenhouse Effect
Acid Deposition (Acid Rain)
Ozone - Stratospheric and Ground-Level
Carbon Dioxide
Sulphur Oxides
Methane
Nitrogen Oxides
Volatile Organic Compounds
Chlorofluorocarbons and Halons
Energy Efficiency
Policy Instruments
Glossary

Other information on energy efficiency, produced by the Energy Efficiency Branch, includes:

Services for Savings – Branch brochure.

Alberta Energy Savers – three series of booklets:

Residential – *Basement Insulation, Caulking and Weatherstripping, Heating Systems, Attic Insulation, Condensation Concerns, Windows, Ventilating Your Home, Water and Electricity, New Homes, Passive Solar, Wood Heating, Storey-and-a-half Insulation, Crawlspace Insulation,* and *Cool Rooms*

Industrial/Commercial/Institutional – *How to Start an Energy Management Program, How to Conduct an Energy Audit, Energy Audit Program, Energy Audit Data, Employee Motivation for Energy Conservation, Efficient Electrical Usage, Efficient Lighting, Efficient Heating,* and *Efficient Ventilation*

Commercial Transportation – *Management for Fuel Economy, Vehicle Selection for Fuel Economy, Maintenance for Fuel Economy, Operating Practices for Fuel Economy, Driving Skills for Fuel Economy*

Energy Conservation UPDATE – branch newsletter.

Energy Savers – fact sheets on energy management for organizations: *Enlightenment on New Fluorescent Savings, Control Your Vehicle Plug-Ins and Save, Electrical Rate Structure, Knowledge Can Save Energy Dollars, Contain Your Energy Costs By Installing a Pool Cover, Tune-up Your Furnace and Save, Simple Steps to Ventilation Savings, Saving Money Through Power Factor Improvement, Turn on the Savings with a Time Clock, Lighten Your Electrical Costs with Energy-Efficient Lamps.*

The above and additional information may be obtained by contacting:

Clean Air Strategy for Alberta
Bag One, Mail Room, Main Floor
North Tower, Petroleum Plaza
9945 - 108 Street
Edmonton, Alberta T5K 2G6
(403) 427-9793 Fax: 427-2278

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GLOSSARY OF TERMS

Acid
A substance which dissolved in water produces a sharp, sour solution; capable of providing hydrogen ions (H^+); common examples are lemon juice, vinegar and battery acid.

Acid Deposition (Acid Rain)
The transfer of acids or acid-forming substances from the atmosphere to the earth's surface.

Acid Deposition Research Program (ADRP)
A government/industry program, conducted from 1985 to 1988, to examine acid deposition in Alberta.

Acid Rain
Rain or snow contaminated by acids formed when air pollutants, especially sulphur dioxide (SO_2) and nitrogen oxides (NO_x), undergo chemical changes in the atmosphere.

Acidic, Acidifying
Acid-forming.

Acidification
A build-up of hydrogen ions above normal levels; the process of becoming acidic.

Acidity
A measure of the concentration of hydrogen ions, often on a pH scale from 1 to 14 where 1 is very acidic, 14 is very basic (alkaline) and 7 is neutral.

Aerosol
A suspension of fine solid or liquid particles in a gas. Smoke and fog are aerosols.

Alkali
A substance that is soluble in water which neutralizes acid. Common examples are ammonia, lye and baking soda.

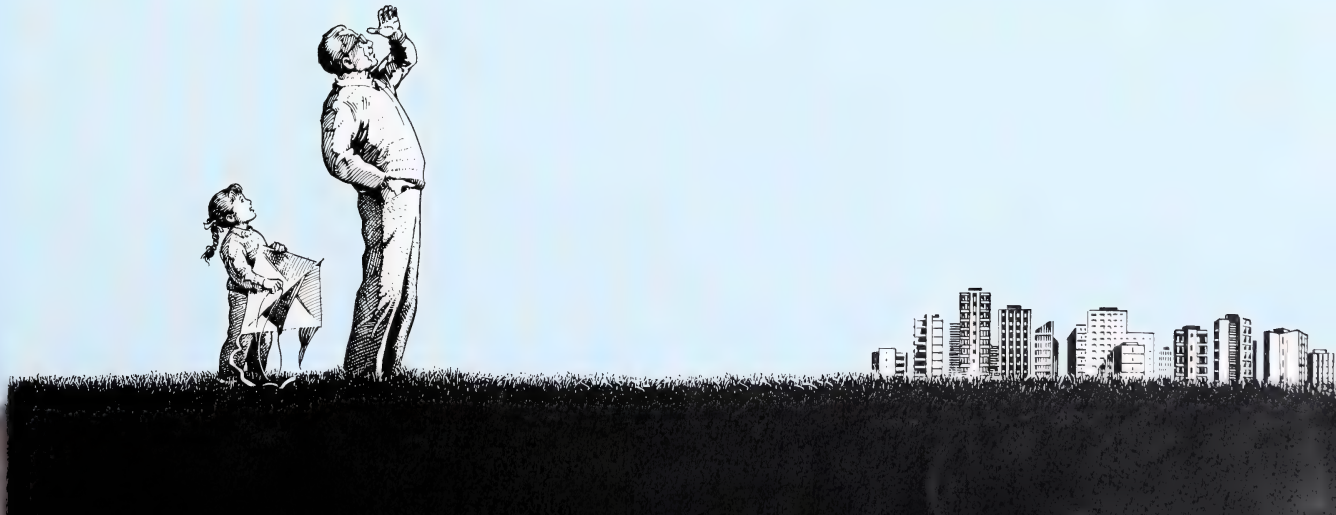
Alkaline
Containing an alkali.

Ambient Air
Outdoor air: all air that plants and animals breathe except the air inside buildings.

Atmosphere
The air surrounding the earth, consisting mainly of nitrogen (about 78 per cent) and oxygen (about 20 per cent). More than 75 per cent of the total mass of the earth's atmosphere is within 10 km of the earth's surface.

Biomass, Plant
Trees and other vegetation.

Bromine (Br)
A toxic, highly corrosive gas of the same chemical group as fluorine and chlorine.



Canadian Council of Ministers of the Environment (CCME)
A council of federal and provincial ministers of environment that coordinates Canada's environment policies.

Carbon Dioxide (CO_2)
A colourless, odourless, non-toxic gas that is essential to plant and animal life and is considered the major greenhouse gas.

Carbon Monoxide (CO)
A colourless, odourless, toxic gas formed when carbon burns with an insufficient supply of oxygen. Carbon monoxide is part of the exhaust gases of motor vehicles.

Chlorine (Cl_2)
A greenish-yellow toxic, corrosive gas used in making drugs, dyes, explosives and plastics, and in bleaching and disinfecting.

Chlorofluorocarbons (CFCs)
Man-made chemical compounds containing chlorine, fluorine, and carbon, that are non-combustible.

Clean Air Strategy for Alberta
An initiative of the Alberta government which will give Albertans an opportunity to participate in discussions related to air quality problems resulting from energy production and use; and to participate in identifying options for action.

Climate Change
Upward or downward trends in average conditions or in the incidence of weather extremes.

Deforestation
The loss of forests, either by tree harvesting or clearing, or through disruption of the natural balance from changes in precipitation, drainage or nutrient supply.

Desertification
The growth of existing deserts or the development of new deserts or desert-like areas due to human impacts or climate change.

Dry Deposition
The transfer of acids and acid-forming substances to the earth's surface by all means that do not involve precipitation. This includes absorption, impaction, sedimentation, and chemical reaction.

Ecosystem
The interaction of organisms and their physical surroundings.

Fluorocarbons
Man-made chemical compounds containing fluorine and carbon.

Fossil Fuels
The remains or traces of prehistoric plants or animals formed in the geological past and removed from the earth in the form of oil, gas and coal.

Global Warming
Increase in the earth's lower atmosphere temperature, possibly the result of the greenhouse effect.

Greenhouse Effect
The phenomenon that occurs when certain atmospheric gases trap radiated heat in the atmosphere.

Halons
Man-made chemical compounds that contain bromine or iodine.

Hydrocarbon (HC)
A compound containing hydrogen and carbon formed by the decomposition of plant and animal remains, including the several types of coal, mineral oil, petroleum, natural gas, paraffin, the fossil resins, and the solid bitumens occurring in rocks. Gasoline is a mixture of hydrocarbons.

Joule
The base unit of energy.

Long Range Transport of Atmospheric Pollutants (LRTAP)
A program of federal, provincial and territorial governments in western and northern Canada to research, monitor and manage acid deposition and other atmospheric pollutants.

Megatonne
One million metric tonnes.

Methane (CH_4)
The most simple of the hydrocarbons; the major component of natural gas.

Montreal Protocol, The
An international protocol dealing with substances that deplete the earth's ozone layer. Adopted by over 40 countries September 16, 1987 in Montreal, it calls for a 50 per cent reduction in chlorofluorocarbons (CFCs) and halons from the 1986 level by 1999. Canada is committed to an 85 per cent reduction by the year 2000.

Nitrogen (N_2)
A colourless, tasteless, gas that makes up about 78 per cent of the earth's atmosphere.

Nitrogen Oxides (NO_x)
Formed when nitrogen (N_2) combines with oxygen (O_2) in the burning of fossil fuels and from the natural degradation of vegetation, and from the use of chemical fertilizers. A significant component of acid deposition and photochemical smog.

Nitrous Oxide (N_2O)
A colourless, slightly sweet-smelling, non-toxic gas which occurs naturally in the atmosphere. Man-made nitrous oxide is used as the anaesthetic commonly called "laughing gas".

Oxidation
Combining or reacting with oxygen.

Oxygen (O_2)
A colourless, tasteless and odourless gas that forms 20 per cent of the air and which is contained in water and most mineral and organic substances. It is essential to plant and animal life.

Ozone (O_3)
A bluish, toxic gas, with a pungent odour, formed of three oxygen atoms rather than the usual two.

Petajoules
An energy measurement. Equals one thousand, million, million or 10^{15} joules.

pH
The measurement of the degree of acidity on a scale from 1 to 14, where 1 is very acidic, 7 is neutral and 14 is very alkaline.

ppmv
Parts per million by volume.

Sinks
Term to describe large areas of vegetation or ocean which absorb compounds such as carbon dioxide.

Smog
Air pollution, light brown colour, containing ground-level ozone, nitrogen oxides and other compounds.

Stratosphere
A layer of the earth's atmosphere, between 10 to 50 km above the earth.

Sulphur (S)
A non-metallic element, yellow in colour, which occurs abundantly in nature. It is a product of sour gas processing and is used in the manufacture of explosives, matches, fertilizer and dyes; as a fungicide, and in medicine; and for vulcanizing rubber.

Sulphur Dioxide (SO_2)
A colourless gas with irritating odour, formed when sulphur burns in air. Dissolves in water to give sulphurous acid..

Sulphur Oxides (SO_x)
Compounds of sulphur of oxygen – the two major ones being sulphur dioxide and sulphur trioxide. They are significant contributors to acid deposition.

Sulphur Trioxide (SO_3)
A colourless gas, formed when sulphur dioxide combines with oxygen in the air. It rapidly combines with water to produce sulphuric acid.

Sulphuric Acid (H_2SO_4)
A strong acid, which is a colourless liquid. When combined with water gives off heat. It is very corrosive and is used extensively in the dyestuffs and explosive industries and as a drying agent in chemical processes.

Sulphurous Acid (H_2SO_3)
A solution of sulphur dioxide in water.

Tonne
Metric ton, equals 1000 kilograms.

Toxic
Having, or tending to have, a harmful effect on the environment or man.

Troposphere
The lower part of the earth's atmosphere, the first 10 km above the earth's surface.

Ultraviolet Radiation or Ultraviolet Light
Naturally present in sunlight but of a wavelength slightly shorter and thus invisible to the human eye. Its high energy levels cause sunburn.

Volatile Organic Compounds (VOCs)
Hydrocarbon chemicals that evaporate easily and play a role in the creation of ground-level ozone.

Wet Deposition
The transfer of acids and acid-forming substances to the earth's surface by precipitation.

Further Information

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Bag One, Mail Room, Main Floor
North Tower, Petroleum Plaza
9945 - 108 Street
Edmonton, Alberta T5K 2G6
(403) 427-9793 Fax: 427-2278

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